

### **AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions and listings of claims in the application:

Claims 1-9 (Canceled)

10. (Currently Amended) ~~The apparatus of claim 1, comprising An~~  
apparatus for monitoring a vascular access associated with an extracorporeal blood circuit, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and at least one fluid transport line cooperating with the extracorporeal blood circuit;

at least a second pump ~~(9, 16)~~ predisposed for circulation of a fluid in another of either the extracorporeal blood circuit or the fluid transport line ~~(15)~~ cooperating with the extracorporeal blood circuit;[[,]]

a memory, containing a mathematical model of the vascular access comprising:

at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the blood; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the first pump;

~~the mathematical model of the vascular access (6) comprising~~ at least a fourth parameter relative to the flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid made to circulate in the second pump;[[.]]

a control and calculation unit connected to the memory and to the first pump and programmed to perform a monitoring procedure which comprises the following operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by the characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the corresponding values of the flow rate of the first pump; and

processing the values stored in memory by means of the mathematical model, in order to determine at least one value of a characteristic of the vascular access.

11. (Currently Amended) The apparatus of claim 10, wherein the ~~unit of~~ control and calculation ~~(17)~~ unit is connected to the second pump ~~(9; 16)~~, and wherein the monitoring procedure further comprises the following stages:

[[ - ]] varying the flow rate of the second pump ~~(9; 16)~~;

[[ - ]] receiving signals corresponding to the values assumed by the blood characteristic at at least one zone of the blood circulation path and for at least two different values of the flow rate of the second pump ~~(9; 16)~~;

[[ - ]] storing in the memory said values of the blood characteristic and the corresponding values of the second pump ~~(9; 16)~~; and

[[ - ]] processing said stored values using the mathematical model for determining at least one value of the vascular access characteristic.

12. (Currently Amended) The apparatus of claim 10, wherein the ~~unit of~~ control and calculation ~~(17)~~ unit is programmed for:

[[ - ]] receiving signals corresponding to the values assumed by the blood characteristic at at least two different zones of the blood

circulation path and for at least two different values of the flow rate of the second pump ~~(9; 16)~~;

[[ -]] storing in the memory said values of the blood characteristic and the corresponding flow rate values of the second pump ~~(9; 16)~~; and

[[ -]] processing said stored values using the mathematical model for determining at least one value of the vascular access characteristic.

13. (Currently Amended) The apparatus of claim 10, wherein the ~~unit of~~ control and calculation ~~(17)~~ unit is programmed to receive at least two signals, for at least two different values of the flow rate of the first pump and a same value of the flow rate of the second pump.

14. (Currently Amended) The apparatus of claim 10, wherein the ~~unit of~~ control and calculation unit is programmed to receive at least two signals, for at least two different values of the flow rate of the second pump and a same value of the flow rate of the first pump.

15. (Currently Amended) The apparatus of claim 10, wherein the ~~unit of~~ control and calculation unit is programmed to maintain the flow rate of the second pump constant during the variation in flow rate of the first pump.

16. (Currently Amended) The apparatus of claim 11, in which the ~~unit of~~ control and calculation unit is programmed to maintain the flow rate of the first pump constant during the variation in flow rate of the second pump.

17. (Canceled)

18. (Currently Amended) ~~The apparatus of claim 17, wherein~~ An apparatus for monitoring a vascular access associated with an extracorporeal blood circuit, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and at least one fluid transport line cooperating with the extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access comprising:  
at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ )

at least a second parameter relating to at least one characteristic ( $P$ ) of the blood;

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the first pump; and

at least one parameter relating to at least one characteristic ( $P_a$ ,  $P_v$ ) of a systemic circulation of a patient, wherein the characteristic of the systemic circulation of the patient is the systemic arterial pressure ( $P_a$ );

a control and calculation unit connected to the memory and to the first pump, the control and calculation unit being configured to receive at least one signal corresponding to the at least one characteristic ( $P_a$ ,  $P_v$ ) and being programmed to perform a monitoring procedure which comprises the following operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by the characteristic ( $P$ ) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the  
corresponding values of the flow rate of the first pump; and  
processing the values stored in memory by means of the mathematical model, in  
order to determine at least one value of a characteristic of the vascular access.

19. (Canceled)

20. (Canceled)

21. (Currently Amended) ~~The apparatus of claim 20, wherein the first~~  
~~sensor (8) is a pressure sensor.~~ An apparatus for monitoring a vascular access  
associated with an extracorporeal blood circuit, wherein the extracorporeal blood circuit  
is connected to the vascular access in a blood withdrawal zone and in a blood return  
zone, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the  
extracorporeal blood circuit and at least one fluid transport line cooperating with the  
extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access comprising:

at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the  
blood; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the  
first pump;

a control and calculation unit connected to the memory and to the first pump and programmed to perform a monitoring procedure which comprises the following operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by the characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the corresponding values of the flow rate of the first pump; and

processing the values stored in memory by means of the mathematical model, in order to determine at least one value of a characteristic of the vascular access;

said control and calculation unit being further connected to at least one pressure sensor configured to detect at least one value of the blood characteristic in a value detection zone that is between the blood withdrawal zone and a blood pump, said value detection zone also including the blood withdrawal zone, and said control and calculation unit being further configured to emit a signal corresponding to the value detected.

22. (Canceled)

23. (Canceled)

24. (Canceled)

25. (Currently Amended)      ~~The apparatus of claim 24, wherein the second sensor (12) is a pressure sensor~~ An apparatus for monitoring a vascular access associated with an extracorporeal blood circuit, wherein the extracorporeal blood circuit

is connected to the vascular access in a blood withdrawal zone and in a blood return zone, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and at least one fluid transport line cooperating with the extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access comprising:

at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the blood; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the first pump;

a control and calculation unit connected to the memory and to the first pump and programmed to perform a monitoring procedure which comprises the following operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by the characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the corresponding values of the flow rate of the first pump; and

processing the values stored in memory by means of the mathematical model, in order to determine at least one value of a characteristic of the vascular access;

said control and calculation unit being further connected to at least a first sensor and a second sensor, the second sensor being a pressure sensor, said first sensor being configured to detect at least one value of the blood characteristic in a first value detection zone that is comprised between the blood withdrawal zone and a blood pump, said first value detection zone also including the blood withdrawal zone, said second sensor being configured to detect at least one value of the blood characteristic in a second value detection zone between the blood pump and the blood return zone, the blood return zone being included in the second value detection zone; said first sensor being configured to emit a first signal corresponding to a value detected by the first sensor, and said second sensor being configured to emit a second signal giving a value detected by the second sensor.

26. (Canceled)

27. (Canceled)

28. (Currently Amended) ~~The apparatus of claim 1, wherein the second parameter relating to at least one blood characteristic is a parameter~~ An apparatus for monitoring a vascular access associated to an extracorporeal blood circuit, comprising:  
at least a first pump predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and at least one fluid transport line cooperating with the extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access comprising:

at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,

$q_v$ )



at least a second parameter relating to at least one characteristic (P) of the blood, said characteristic (P) relating to blood pressure; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the first pump;

a control and calculation unit connected to the memory and to the first pump and programmed to perform a monitoring procedure which comprises the following operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by the characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the corresponding values of the flow rate of the first pump; and

processing the values stored in memory by means of the mathematical model, in order to determine at least one value of a characteristic of the vascular access.

29. (Currently Amended) The apparatus of claim 28, wherein the second parameter is a parameter relating to the blood pressure in a blood withdrawal zone of the vascular access (6).

30. (Currently Amended) The apparatus of claim 28, wherein the second parameter is a parameter relating to the blood pressure in a blood return zone of the vascular access (6).

31. (Currently Amended) ~~The apparatus of claim 1, wherein the An~~  
apparatus for monitoring a vascular access associated with an extracorporeal blood  
circuit, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the  
extracorporeal blood circuit and at least one fluid transport line cooperating with the  
extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access, said  
mathematical model ~~contained in the memory describes~~ describing a pressure variation  
in the vascular access (6) as a function of ~~the~~ a blood flow rate, the mathematical model  
comprising:

at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  
 $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the  
blood; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the  
first pump;

a control and calculation unit connected to the memory and to the first pump and  
programmed to perform a monitoring procedure which comprises the following  
operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by  
the characteristic (P) of the blood in at least one zone of the blood circulation path and  
with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the  
corresponding values of the flow rate of the first pump; and  
processing the values stored in memory by means of the mathematical model, in  
order to determine at least one value of a characteristic of the vascular access.

32. (Canceled)

33. (Currently Amended) ~~The apparatus of claim 1,~~ An apparatus for  
monitoring a vascular access associated with an extracorporeal blood circuit,  
comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the  
extracorporeal blood circuit and at least one fluid transport line cooperating with the  
extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access, wherein the  
mathematical model comprises one or more of the following equations:

$$q_a = \frac{P_a - P_{af}}{R_d}$$

$$P_{af} - P_{vf} = R_f \cdot (q_a - q_b)$$

$$P_{vf} - P_v = R_v \cdot (q_a - q_{uf})$$

said memory comprising:

at least a first parameter relating to at least one characteristic ( $R_d, R_f, R_v, q_a, q_b,$   
 $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the  
blood; and

at least a third parameter relating to a flow rate ( $q_b, q_{uf}$ ) of the fluid moved by the  
first pump;

a control and calculation unit connected to the memory and to the first pump and  
programmed to perform a monitoring procedure which comprises the following  
operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by  
the characteristic (P) of the blood in at least one zone of the blood circulation path and  
with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the  
corresponding values of the flow rate of the first pump; and

processing the values stored in memory by means of the mathematical model, in  
order to determine at least one value of a characteristic of the vascular access.

34. (Canceled)

35. (Canceled)

36. (Canceled)

37. (Currently Amended)      ~~The apparatus of claim 36,~~ An apparatus for  
monitoring a vascular access associated to an extracorporeal blood circuit, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the  
extracorporeal blood circuit and at least one fluid transport line cooperating with the  
extracorporeal blood circuit;

a memory, containing a first mathematical model of the vascular access  
comprising:

at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_t$ ,  
 $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the blood; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the first pump;

a control and calculation unit connected to the memory and to the first pump and programmed to perform a monitoring procedure which comprises the following operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by the characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the corresponding values of the flow rate of the first pump; and

processing the values stored in memory by means of the mathematical model, in order to determine at least one value of a characteristic of the vascular access;

said control and calculation unit being configured to receive signals corresponding to the values of the blood characteristic in at least a first detection zone of the circuit, distant from a blood withdrawal zone from the vascular access and a second detection zone of the circuit, distant from a blood return zone of the vascular access;

wherein the said memory contains a second mathematical model of the variation of the blood characteristic between the blood withdrawal zone and the first detection zone and a third mathematical model for the variation of the blood characteristic

between the blood return zone and the second detection zone; the ~~unit of~~ control and calculation ~~(17)~~ unit being programmed to process, using the second and third mathematical ~~model~~ models, the values of the blood characteristic relating to the first and second detection zone ~~zones~~, and to determine at least one value of the blood characteristic which relates to each of the blood withdrawal and return ~~zone~~ zones.

38. (Original) The apparatus of claim 37, wherein at least one of the second and third mathematical models comprises at least one parameter relating to the blood flow rate.

39. (Original) The apparatus of claim 37, wherein at least one of the second and third mathematical models comprises at least one parameter relating to hematocrit of the blood.

40. (Currently Amended) The apparatus of claim 37, wherein:  
[[ - ]] at least one of the second and third mathematical models comprises at least one series of experimentally-determined coefficients ~~which~~ that are characteristic of an access tool ( $N_A$ ,  $N_V$ ) used for connecting the extracorporeal circuit with the vascular access ~~(6)~~ during a blood withdrawal or return stage; and

[[ - ]] the memory contains coefficients ~~which~~ that are characteristic of a plurality of access tools ( $N_A$ ,  $N_V$ ) of different types and is predisposed configured to ~~recognise~~ recognize a type of access tool used time-by-time and to use, in at least one of the second and third mathematical models, the coefficients which are characteristic of ~~the a~~ type of access tool ~~recognised~~ recognized.

41. (Canceled)

42. (Canceled)

43. (Canceled)

44. (Currently Amended) ~~The apparatus of claim 42, wherein the blood-~~  
~~characteristic is the blood pressure and the~~ An apparatus for monitoring a vascular  
access associated with an extracorporeal blood circuit, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the  
extracorporeal blood circuit and at least one fluid transport line cooperating with the  
extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access comprising:  
at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  
 $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the  
blood, said characteristic relating to blood pressure; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the  
first pump;

a control and calculation unit connected to the memory and to the first pump and  
programmed to perform a monitoring procedure which comprises the following  
operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by  
the blood pressure in at least one zone of the blood circulation path and with at least  
two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the  
corresponding values of the flow rate of the first pump;

processing the values stored in memory by means of the mathematical model, in order to determine at least one value of a characteristic of the vascular access;  
receiving, at regular intervals, signals relating to the values of the blood characteristic in at least one zone of the blood circulation path during a variation of flow rate of the first pump;  
evaluating changes in the values of the blood characteristic; and  
using the blood characteristic values for a following processing operation when the variation has exceeded a threshold value, said threshold value is being about 2 mm Hg.

45. (Currently Amended) ~~The apparatus of claim 1, wherein the unit of control and calculation (17) is programmed to:~~ An apparatus for monitoring a vascular access associated with an extracorporeal blood circuit, comprising:

at least a first pump predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and at least one fluid transport line cooperating with the extracorporeal blood circuit;

a memory, containing a mathematical model of the vascular access comprising:  
at least a first parameter relating to at least one characteristic ( $R_d$ ,  $R_t$ ,  $R_v$ ,  $q_a$ ,  $q_t$ ,  $q_v$ )

at least a second parameter relating to at least one characteristic (P) of the blood; and

at least a third parameter relating to a flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid moved by the first pump;



a control and calculation unit connected to the memory and to the first pump and  
programmed to perform a monitoring procedure which comprises the following  
operating stages:

varying the flow rate of the first pump;

receiving the signals corresponding to the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by  
the characteristic (P) of the blood in at least one zone of the blood circulation path and  
with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the first pump;

storing in memory the values of the characteristic of the blood and the  
corresponding values of the flow rate of the first pump;

processing the values stored in memory by means of the mathematical model, in  
order to determine at least one value of the characteristic of a vascular access;

said control and calculation unit being further programmed to:

[[ - ]] reach a steady state after having maintained the flow rate of each pump at  
a constant rate for a determined period of time;

[[ - ]] store and process values of the blood characteristic in the steady state.

46. (Currently Amended) The apparatus of claim 10, wherein the ~~unit of~~  
control and calculation ~~(17)~~ unit is programmed to perform a monitoring procedure  
comprising which comprises the following operative stages:

[[ - ]] changing the flow rate of the first pump;

[[ - ]] changing the flow rate of the second pump;

[[ - ]] receiving signals relating to the values of the blood characteristic in at  
least one zone of the blood circulation path, for at least two different  
values of the first pump flow rate and for at least two different values of the  
second pump flow rate;

[[ -]] storing said values of the blood characteristic and ~~the correspondence~~  
corresponding values of the first pump flow rate and the second pump flow  
rate; and

[[ -]] processing said values stored by means of the mathematical model to  
determine at least one value of the vascular access characteristic.

47. (Currently Amended) A machine for treatment of blood in an  
extracorporeal circuit, comprising a monitoring apparatus according to any one of claims  
~~from 1 to 46~~ 10, 18, 21, 25, 28-31, 33, 37-40, and 44-46.

48. (Canceled)

49. (Canceled)

50. (Canceled)

51. (Withdrawn) A method for monitoring a vascular access of an  
extracorporeal blood circuit, comprising the stages of:

- storing in memory at least one mathematical model of the vascular access;
- varying the flow rate of at least one fluid running in at least one of the extracorporeal blood circuit (5, 10) and the at least one fluid line (15) cooperating with the extracorporeal blood circuit (15);
- determining the values of at least one blood characteristic (P) in at least one zone of the blood circulation path and at at least two different values of the flow rate of the fluid;
- storing in memory said values of the blood characteristic and the corresponding values of the flow rate of the fluid;
- determining at least one value of a characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ ) of the vascular access by means of the mathematical model and the stored values.

52. (Withdrawn). The method of claim 51, wherein the mathematical model of  
the vascular access comprises:

- at least a first parameter relating to the characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ ) of the vascular access;
- at least a second parameter relating to the blood characteristic ( $P$ ); and
- at least a third parameter relating to the flow rate ( $q_b$ ,  $q_{uf}$ ) of the fluid running in at least one of the extracorporeal blood circuit (5, 10) and the line (15) cooperating with the extracorporeal blood circuit.

53. (Withdrawn) The method of claim 51, wherein the stage of determining the values of a blood characteristic comprises the following sub-stages:

- determining the values of the blood characteristic in at least a first zone of the blood circulation path and for at least two different values of the flow rate of the fluid;
- determining the values of the blood characteristic in at least a second zone of the blood circulation path which is distant from the first zone, and for at least two different values of the flow rate of the fluid.

54. (Withdrawn) The method of claim 53, wherein the said at least two different values of the flow rate of the fluid by which the values of the blood characteristic in the first zone are determined are equal to the said two values of the flow rate by which the values of the blood characteristic in the second zone are determined.

55. (Withdrawn) The method of claim 51, wherein:

- the said stage of variation of the flow rate of at least one fluid comprises the sub-stages of:
  - o varying the flow rate of a first fluid running in the extracorporeal circuit (5; 10) , and -
  - o varying the flow rate of a second fluid-running in a line (15) connected to the extracorporeal circuit (5; 10)
- the said stage of determining the values of at least one blood characteristic consists in determining the said values in at least one zone of the blood circulation path, and at at least two different flow

rate values of the first fluid, and at at least two different flow rate values of the second fluid.

56. (Withdrawn) The method of claim 51, wherein the said stage of varying the flow rate of at least one fluid consists in varying -the blood flow rate in the extracorporeal circuit (5; 10)

57. (Withdrawn) The method of claim 51, wherein the values of the blood characteristic are determined in at least two different zones of the blood circulation path.

58. (Withdrawn) The method of claim 51, wherein the said stage of varying the flow rate of at least one fluid consists in varying a flow rate of a discharge fluid running in a drainage line (15) connected to the extracorporeal circuit (5; 10) by means of a semi-permeable membrane (4)

59. (Withdrawn) The method of claim 51, wherein the stage of varying the flow rate of at least one fluid consists in varying the blood flow rate in the extracorporeal circuit (5; 10), and in varying the flow rate of a discharge fluid running in a drainage line (15) connected to the extracorporeal circuit by means of a semi-permeable membrane (4).

60. (Withdrawn) The method of claim 51, wherein the mathematical model comprises at least one parameter relating to at least one characteristic ( $P_a$ ,  $P_v$ ) of the systemic circulation of the patient.

61. (Withdrawn) The method of claim 60, comprising a stage of determining at least one value for the said at least one characteristic ( $P_a$ ,  $P_v$ ) of the systemic circulation of the patient, a stage of storing the said at least one value and a stage of using the said at least one value for determining the characteristic of the vascular access (6).

62. (Withdrawn) The method of claim 60, wherein the said characteristic of the systemic circulation system of the patient is the systemic arterial pressure (Pa).

63. (Withdrawn) A method for monitoring a vascular access of an extracorporeal blood circuit, wherein the extracorporeal blood circuit (5; 10) is connected to a first chamber (2) of a blood treatment unit (1) having a second chamber (3) which is separated from the first chamber (2) by a semi-permeable membrane (4), and which is provided with an outlet connected to a drainage line (15) of a discharge fluid, the method comprising the stages of:

- storing in memory a mathematical model of the vascular access (6)
- varying the flow rate of the discharge fluid in the drainage line (15)
- determining the values of a blood characteristic in at least one zone of the blood circulation path and at at least two different values of the discharge fluid flow rate;
- storing in memory the said values of the blood characteristic and the corresponding values of the discharge fluid flow rate;
- determining at least one value of the vascular access characteristic using the mathematical model and the said stored values.

64. (Withdrawn) The method of claim 63, wherein the values of the blood characteristic are determined in at least two different zones of the blood circulation path.

65. (Withdrawn) A method for monitoring a vascular access of an extracorporeal blood circuit, wherein the extracorporeal blood circuit (5; 10) is connected to a first chamber (2) of a blood treatment unit (1) having a second chamber (3) which is separated from the first chamber (2) by a semi-permeable membrane (4), and which is provided with an outlet connected to a drainage line (15) of a discharge fluid, the method comprising the stages of:

- storing in memory a mathematical model of the vascular access (6)

- varying the flow rate of the discharge fluid in the drainage line (15);
- varying the blood flow rate in the extracorporeal blood circuit;
- determining the values of a blood characteristic in at least one zone of the blood circulation path and at at least two different values of the discharge fluid flow rate and at at least two different values of the blood flow rate;
- storing in memory the said values of the blood characteristic and the corresponding values of the discharge fluid flow rate and the blood flow rate;
- determining at least one value of the vascular access characteristic using the--said mathematical model and the said stored values.

66. (Withdrawn) The method of claim 56, wherein the discharge fluid is a product of ultrafiltration which passes across the semi-permeable membrane (4)

67. (Withdrawn) The method of claim 56, wherein the blood characteristic is determined at at least two different values of - the discharge fluid flow rate, and at a same value of the blood flow rate.

68. (Withdrawn) The method of claim 57, wherein the blood characteristic is determined at at least two different values of the blood flow rate, and at a same value of the discharge fluid -flow rate, and at at least two different values of the discharge fluid flow rate, and at a same value of the blood flow rate.

69. (Withdrawn) The method of claim 56, wherein the blood flow rate is maintained constant during the variation of the discharge fluid flow rate.

70. (Withdrawn) The method of claim 57, wherein the discharge fluid flow rate is maintained constant during the variation of the blood flow rate.

71. (Withdrawn) The method of claim 52, wherein the mathematical model of the vascular access (6) comprises at least a fourth parameter relating to the flow rate

(qb, quf) of a fluid which runs in one or another of the extracorporeal blood circuit (5; 10) and the drainage line (15) cooperating with the extracorporeal blood circuit (5; 10)

72. (Withdrawn) The method of claim 52, wherein the second parameter relates to a physical or chemical or physical-chemical property of the blood, which property has a correlation with the blood flow rate, the mathematical model being a model describing the correlation.

73. (Withdrawn) The method of claim 72, wherein the blood property is the blood pressure.

74. (Withdrawn) The method of claim 52, wherein the first parameter relates to at least one fluid-dynamic characteristic of the vascular access (6), the mathematical model being a fluid-dynamic model of the vascular access (6)

75. (Withdrawn) The method of claim 51, wherein the extracorporeal blood circuit comprises a blood withdrawal line (5), connected to a blood withdrawal zone of the vascular access (6) of a patient, and a blood return line (10), connected to a blood return zone of the vascular access (6)

76. (Withdrawn) The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in a zone of the extracorporeal blood circuit located downstream of the blood withdrawal zone.

77. (Withdrawn) The method of claim 75, wherein a blood pump (9) operates in the extracorporeal blood circuit to cause the blood to circulate, and wherein the measurement is taken upstream of the blood pump (9).

78. (Withdrawn) The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in the blood withdrawal zone of the vascular access (6) .

79. (Withdrawn) The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in a zone of the extracorporeal blood circuit which is upstream of the blood return zone.

80. (Withdrawn) The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in the blood return zone of the vascular access.

81. (Withdrawn) The method of claim 51, wherein a blood treatment unit (1) operates in the extracorporeal blood circuit; and wherein the value of the blood characteristic is determined by measurement performed downstream of the blood treatment unit (1).

82. (Withdrawn) The method of claim 51, wherein the mathematical model stored in the memory is a mathematical model of a change in pressure in the vascular access as a function of the blood flow rate.

83. (Withdrawn) The method of claim 52, wherein the first parameter is chosen from the parameters relating to one or more of the following characteristics of the vascular access (6): the blood flow rate ( $q_a$ ) upstream of a blood withdrawal zone from the vascular access (6); the blood flow rate ( $q_f$ ) between the blood withdrawal zone and a blood return zone at the vascular access (6); the blood flow rate ( $q_v$ ) downstream of the blood return zone; the vascular hydraulic resistance ( $R_d$ ) upstream of the blood withdrawal zone; the vascular hydraulic resistance ( $R_f$ ) between the blood withdrawal



zone and the blood return zone; the vascular hydraulic resistance (Rv) downstream of the blood return zone.

84. (Withdrawn) The method of claim 51, wherein the mathematical model comprises one or more of the following equations:

$$q_a = \frac{P_a - P_{af}}{R_d}$$
$$P_{af} - P_{vf} = R_f \cdot (q_a - q_b)$$
$$P_{vf} - P_v = R_v \cdot (q_a - q_{uf})$$

85. (Withdrawn) The method of claim 51, wherein the value of the blood characteristic is determined by measuring in the extracorporeal circuit in at least a first detection zone, distant from a blood withdrawal zone at the vascular access (6).

86. (Withdrawn) The method of claim 85, wherein the memory contains a second mathematical model of the variation in the blood characteristic between the blood withdrawal zone and the first detection zone; the second mathematical model being used to determine at least one value of the blood characteristic relating to the blood withdrawal zone.

87. (Withdrawn) The method of claim 51, wherein the said value of the said blood characteristic is determined by measurement in the extracorporeal circuit (5; 10) in at least a second detection zone, distant from the blood return zone to the vascular access (6)

88. (Withdrawn) The method of claim 87, wherein the memory contains a third mathematical model of the variation in the said blood characteristic between the blood return zone and the second detection zone; the second mathematical model

being used to determine at least one value of the said blood characteristic relating to the blood return zone.

89. (Withdrawn) The method of claim 86, wherein at least one of the second mathematical model and the third mathematical model comprises at least one parameter relating to the blood flow rate.

90. (Withdrawn) The method of claim 86, wherein at least one of the second mathematical model and the third mathematical model comprises at least one parameter relating to the blood hematocrit.

91. (Withdrawn) The method of claim 51, comprising operations of:

- determining at regular intervals the values of the said blood characteristic in at least one zone of the blood circulation path during at least one flow rate variation;
- evaluating the variation in the said values;
- using, in determining at least one value of the said characteristic of the vascular access, the values of the said blood characteristic when the said variation exceeds a threshold value.

92. (Withdrawn) The method of claim 51, comprising operations of:

- determining at regular intervals the values of the said blood characteristic in at least two different zones of the blood circulation path during at least one flow rate variation; -
- calculating the difference between the variation of the said blood characteristic detected in a first zone of the blood circulation path and the variation of the said blood characteristic detected in a second zone of the blood circulation path;
- using, in determining at least one value of the said characteristic of the vascular access, the values of the said blood characteristic when the said difference has exceeded a threshold value.

93. (Withdrawn) The method of claim 91, wherein the said blood characteristic is the blood pressure and the threshold value is about 2 mmHg.

94. (Withdrawn) The method of claim 51, comprising the stages of:
- reaching a steady state after having maintained each flow rate constant for a determined period of time;
  - storing and processing the values of the said blood characteristic in the said steady state.

95. (Canceled)

96. (Canceled)

97. (Currently Amended) ~~The method of claim 95,~~ A method for operating a blood treatment machine for determining hemodynamic parameters during extracorporeal blood treatment, wherein blood is sent to a blood treatment unit via an arterial line of an extracorporeal blood circuit which is connected with a vascular access, and is returned via a venous line of the extracorporeal blood circuit; at least a pump being configured for circulation of a fluid in at least one of the extracorporeal blood circuit and at least one fluid transport line cooperating with the extracorporeal blood circuit, the method comprising the stages of:

varying the flow rate of the pump;

determining the values ( $P_{af}$ ,  $P_{am}$ ,  $P_{vf}$ ,  $P_{vm}$ ) assumed by a characteristic (P) of the blood, wherein the said blood characteristic (P) is the blood pressure, in at least one zone of the blood circulation path and with at least two different values of the flow rate ( $q_b$ ,  $q_{uf}$ ) of the pump;

storing in a memory said values of the characteristic (P) of the blood and corresponding values of the flow rate of the pump;

processing the values stored in the memory by calculating at least one solution of a mathematical model, in order to determine at least one value of at least one characteristic ( $R_d$ ,  $R_f$ ,  $R_v$ ,  $q_a$ ,  $q_f$ ,  $q_v$ ) of the vascular access, the mathematical model

describing a relationship between the difference of the characteristic (P) of the blood at a first and second point of the intracorporeal blood circulation path and the blood flow rate ( $q_a$ ,  $q_f$ ,  $q_v$ ) flowing between the first and second points.

98. (Canceled)